SOCIOECONOMIC IMPLICATIONS AND PROTECTION STRATEGIES OF FLOODING IN PRAGUE, CZECH REPUBLIC

by

Audrey Spiegel

In Partial Fulfillment
of the Requirements for the Degree of
Master of City and Regional Planning in the
School of City and Regional Planning

Georgia Institute of Technology
May 2014

SOCIOECONOMIC IMPLICATIONS AND PROTECTION

STRATEGIES OF FLOODING IN PRAGUE, CZECH REPUBLIC

Approved by:

Dr. Bruce Stiftel, Advisor
School of City and Regional Planning
Georgia Institute of Technology

Date Approved: [Date Approved by Committee]

SOCIOECONOMIC IMPLICATIONS AND PROTECTION STRATEGIES OF FLOODING IN PRAGUE, CZECH REPUBLIC

TABLE OF CONTENTS

SUMMARY

With weather events becoming more intense, governments need to take extra precautions to make their cities and regions more resilient to these climate change related disasters. Disaster prevention and response requires a tremendous amount of financial support and often requires more resources than a city is capable of providing on its own. Therefore, the governments must make decisions when allocating these resources. Priorities must be established. This research paper aims to determine whether or not certain districts of Prague face more flood damages than other areas. The research attempts to determine if there is a correlation between the socioeconomic status of the district and the amount of flood damage it receives.

I was able to determine that flood levels in each district for 2002 and 2013 is telling in the Czech government's potential flood protection strategies. The area that received the most flooding, Prague 16, received much less flooding in 2013. This suggests that this area may have been heavily protected. Prague 1 also received less flooding. This area, the city center (for business and tourism) would have been one of the most protected areas for the 2013 floods. Prague 7, with the highest numbers, only changed slightly between the two years (change of 9.3%). This suggests that more precautionary protection measures should be put into place in order to prevent these high damages for the next major flood.

.

CHAPTER 1

INTRODUCTION

Scientists and researchers are finding a connection between greenhouse gas emissions and unpredictable, intensified weather patterns. Subsequently, global concern about climate change is rising. Governments and policy makers all over the world must adapt their countries, cities, and regions to withstand these changing weather patterns. Specifically, flooding is predicted to become more problematic as climate change intensifies. According to the 2013 Intergovernmental Panel on Climate Change (Stocker et al., 2013, p. 158) studies using Special Report of Emission Scenario (SPES) modeling indicate climate change will continue to influence the intensity and frequency of weather patterns in the future. SPES models are based on different levels of baseline global greenhouse gas emissions between 2000 and 2030. The report states that while precipitation will increase in some areas and decrease in other more arid climates, there will be a "general intensification of the global hydrological cycle, and of precipitation extremes, are expected for a future warmer climate" (Stocker et al., 2013, p. 984). Cities unpreparedness for these natural disasters results in exorbitant and perhaps preventable deaths, injuries, and property damages.

Disaster prevention and response requires a tremendous amount of financial support and often requires more resources than a city is capable of providing on its own. Therefore, the governments must make decisions when allocating these resources. Priorities must be established. When disaster strikes and emergency response and resources are needed, what affected area get treatment first? Do other areas receive help after the fact or not at

all? These questions bring up an important issue in disaster management and prevention. Disaster prevention and relief questions can represent whether or not there are underlying socioeconomic disparities and inequalities in the area. If so, what steps can cities take to correct these injustices?

Socioeconomic issues are prominent during natural disasters because there are always certain areas of a city, people of certain ethnicity, or people of a specific socioeconomic status who are more vulnerable to extreme weather events. Vulnerable populations are usually lower-income, live in lower-quality dwelling units, and are forced to live in hazardous areas that are undesirable for people who have the ability to live elsewhere. During crisis management, are some populations more negatively affected than others?

Prague is among many central European cities that experienced several extreme flooding events within the past few decades. Like many major cities around the world, Prague is situated along a major river for convenience to navigable waters. Rivers often serve as the foundation and can be responsible for the success of a city, but can also be responsible for damaging them. The Vltava River in Prague is no exception. The areas that surround the Vltava in Prague have been vulnerable to major flood events within the past twenty years, specifically in 2002 and 2013. Two of the affected areas are major tourism and business districts while others are residential and commercial. After these floods, the Czech government must allocate flood protection and recovery resources. This research paper aims to determine whether or not certain districts of Prague face more flood damages than other areas. It will attempt to determine if there is a correlation

between the socioeconomic status of the district and the amount of flood damage it receives. Additionally, it will analyze the Czech Republic's flood management and protection strategies already in place.

The research of this paper will be based on socioeconomic characteristics of each Administrative district along the Vltava River. Socioeconomic data is gathered from the Czech Statistical Office These socioeconomic factors are rate of low quality dwellings, rate of people with no formal education, and rate of non-Czechs (specifically Ukrainian, Roma, Vietnamese, Slovakian per Administrative district). The socioeconomic factors will be used in conjunction with flood level and flood damage data from the August 2002 and June 2013 floods in Prague. The flood damage information per Administrative district will determine if there is a correlation between damage/ flood levels and socioeconomic factors in Prague. Additionally, this information will beused to determine if flooding improved in the districts from 2002 and 2013.

The first section of this paper will discuss Prague's history and flooding vulnerability. The August 2002 will be analyzed to serve as a comparison for the June 2013 floods. The second section is the Literature Review which will provide information to address the following issues: General socioeconomic implications of flooding, General and Czech specific flood management. The third section of the paper will explain the research design, methodology, and the research findings. This will incorporate flood data, images and the socioeconomic information of Prague's administrative districts. The final section

of the report will conclude my findings and provide recommendations for planners, for Prague, and for further research.

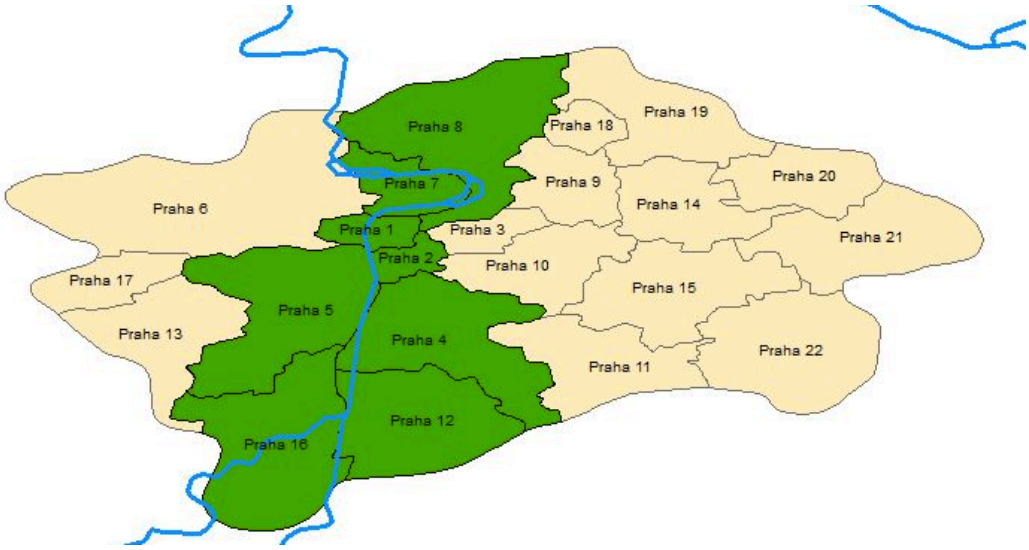
History of Flooding in Prague

While Prague's first settlers migrated to area during the Stone Age, it did not become a city until the 12th century. During this time the Old Town and Mala Strana (Lesser Town) were intentionally constructed along the meandering Vltava River ("Prague History," 2010). The Vltava played a major role in Prague's growth because it "provided vital water for drinking and crop irrigation, and a means of navigation for both the early settlements establishing along its banks and for travellers on the early trade routes between Southern and Northern Europe" ("Vltava River,"). It is the longest river in the Czech Republic with two tributaries, Teplá Vltava (Warm Vltava) and Studená Vltava (Cold Vltava). The Vltava travel through Germany and drains in the Elbe (Labe) River. While the river is responsible to Prague's foundation and contributes to the city's unique character, it has also contributed to major flood events over the past few decades. The word Vltava means torrential or wild river, which is a accurate representation of the river during flood events in Prague.

The City is composed of twenty-two administrative districts, and like many districts in a single city, they all differ in character and history. The districts range from Prague 1 and Prague 22. Each district is its own municipality and is comprised of an individual mayor and local government. This research will focus on the flood prone areas, thus the districts located along the Vltava River will be the primary area of

focus. These districts are represented in the map below and highlighted in green. They include (Ranging from North to South):

Figure 1



- Prague 8- (Brezineves, Dablice, Dolni Chabry, Karlin)
- Prague 7 (Letna, Troja, Liben Holesovice, Bubenec)
- Prague 1- The Center/ Old Town
- Prague 2- Nove Mesto
- Prague 5- Smichov
- Prague 4- Pondoli
- Prague 16- Chuchle
- Prague 12- Modrany

August 2012 Floods

In August 2002, the Czech Republic was hit with a flood even that was well beyond the country's scope of knowledge and experience. The results were devastating, to both people and the economy. Prague is one of the most famous cities in Europe, and therefore, attracts many tourists every year. The floods prevented the city from collecting revenue from the tourism industry on which its economy relies so heavily. Homes and businesses also surround the Vltava River were also affected. Overall, the floods placed an overwhelming burden on individuals in the city.

To illustrate the magnitude of the event, it can only be compared to another flood event in Bohemia's history. The Vltava, "after 4 days and 3 nights of rain, flooded Prague's Old Town and the lower parts of the Little Town were allowing for transport by boat only. Mills on the Vltava were washed away, many houses demolished, people and cattle drowned, fields flooded, and more. The stone Charles Bridge was destroyed in five places" (256). The impacts were astronomical. They caused over $26.17 billion in damages and killed 18 people. A few issues were responsible for the extent of this flood event. It came in two phases and after the "first wave of rainfall, the retention capacity of the upper Vltava basin was completely exhausted. The retention capacities of the reservoirs of the Vltava cascade were kept according to the valid operating curves, but the dispatchers were helpless against the volume of water rushing down the basin"(Sklenář, Zeman, Špatka, & Tachecí, 2006). As a result, the Vltava rose and spilled over into the city.

Although wild or torrential is rooted in the Vltava's name, major flood events do not dominate the Czech Republic or Czechoslovakia's history. The intensity of the floods surpassed any on record, and therefore, the city could not adequately prepare for it. Determined by archaic watermarks, one of the worst floods Czech history occurred in March of 1845 and is then followed by the floods of August 2002. This is a substantial gap between major flood events in the Czech Republic and for the "first time in the last century, the Czech Republic experienced a major flood whose rate significantly exceeded the passage of a 100- year water"(Jirasek, 2006, p. 256). Because of these sporadic major flood events, the country might not have been equipped to deal with the intensity of these floods. The

> *"hydrologic monitoring network was underinvested within the last century. During the flood, most of the guage stations at the rivers were destroyed, some were not able to transmit or even record data under the unexpectedly high water level conditions A meteorlogical forecast was available and quite accurate. Hydrological forecast was not available fully in the later stages, because most of the models were out of range and on-line data were hardly available later during the event" (Jirasek, 2006, p. 256)*

The history of flooding in the Czech Republic/ Czechoslovakia indicates that the country does not have sufficient experience to protect the land and people from extreme flooding. While such flooding has taken place in ancient history, preparing for floods today is

much different, even if its intensity is similar. The flood events "of the equivalent intensity have nowadays more catastrophic consequences than in the part in connection with the more and more complex infrastructure of human society and with the growing degree of anthropogenic re-shaping of the cultural landscape" (Jirasek, 2006, p. 264). The country was neither equipped nor prepared for the sudden flooding in August of 2002.

This flood taught the Czech Republic many lessons for flood protection in the future. After the 2002 Floods, the Water Management Resesarch Institute published a report that evaluated the floods and its effects on the city. The following were important conclusions from the report:

- [The Czech Republic] must consistently enforce the flood prevention principles; in particular, regulate the land utilization in the delineated flood-prone areas and in their active zones

- Safeguard the waste water treatment plants (WWTPs) against flood damage since nonfunctional WWTPs were among the leading sources of the surface water quality impairment

- The comprehensive evaluation indicates that the rainfall in the sub- basins affected during the 2002 flood situation reached 68% of the probable maximum precipitation (PMP); in future, heavier precipitations can be expected thus it is necessary to supply major urban areas authorities and industrial plants managements with flood plans in case there is a flood of the occurrence rate exceeding the 100- year return period

- Build up storage capacity by suitable land modifications and by revitalization of the regulated sections of small watercourses
- Continue in delineation of flood-prone areas and in the implementation of flood-prevention and protection measures
- Improve the information system by means of automation of the precipitation and hydrometric stations, and utilize the close linkage onto the European forecasting system (Jirasek, 2006, p. 264)

June 2013 Floods

June 2013 proved to be a trying time in the Czech Republic. Multiple days of heavy rainfall caused the Vltava River to quickly rise and threatened Prague with severe flooding. The river was said to be ten times its normal level. The Vltava Cascade, a collection of nine dams, were "dangerously full" (Fraser, 2013) and floodgates had to be opened. The famous Charles Bridge was closed for tourists, Kampa Park (a famous area in Prague's center) was underwater, and a handful of metro stations had to be closed. Although these floods were not as severe as the August 2002 floods, the event caused major damage. The damages from this flood reached 1.76 billion CZK, which is 91.3 million U.S. Dollars" ("Czech Republic: Insurers to tighten conditions for properties near floodplains," 2013). Additionally, three thousand people were forced to evacuate their homes and leave their belongings behind (Fraser, 2013)

CHAPTER 2

FLOODING: SOCIOECONOMIC IMPLICATIONS AND PROTECTION STRATEGIES

People of low-socioeconomic status commonly inhabit areas that are undesirable areas because of their exposure to certain hazards, like floodplains. Inexpensive infrastructure and housing are also less resilient to natural disasters, and therefore, the low-socioeconomic residents have no choice but to reside in these areas. Flooding has caused physical and economic devastation in Prague over the past two decades. Three fatal floods, in 2002, and 2013, caused billions of dollars worth of damage, and have presented the Czech Republic with extreme social and economic challenges. Such natural disasters repeatedly illustrate the vulnerability of certain communities. Before continuing, it is important to first to be aware of how floods are understood in the Czech Republic. Chapter 9: Protection Against Floods, of the Czech Republic's Act Water Act defines floods as "temporarily marked increase in the water level in a watercourse or other surface water body, causing water to flood the surrounding land outside the watercourse channel, and being possible causing factor of a damage" ("The Water Act," 2001, p. 34). Therefore, as flood disasters become more frequent and intense in the Czech Republic, it is important for governing bodies to be aware of the flood situation in relation to lower socioeconomic areas or Prague. This research aims to answer the following questions that explore the relationship between floods and socioeconomic indicators in Prague's municipalities. These questions are the following:

- Are there certain areas of Prague repeatedly more affected by floods than others?

- If so, are there certain shared socioeconomic characteristics of those areas?
- Do Prague's flood measures and policies appropriately and affectively protect vulnerable areas from flooding.

Before answering these questions, the following literature explains socioeconomic indicators of disasters and flood management and protection strategies globally and specifically in the Czech Republic.

Socioeconomic Implications of Flooding

Globally, people of lower socioeconomic status tend to occupy at risk areas and this makes them less resilient to natural disasters. First, understanding the term at "risk" is necessary. The term at "risk" indicates that"(1) without people or property, there is no risk and (2) one should pay equal attention to the flood hazard and society's vulnerability" (Klijin 2010, 309). This definition suggests that "demographic and economic developments urge us to reconsider the current flood risk management strategies as vulnerability mounts. This implies a shift away from the single objective of flood defense, via control of the flood hazard (physical defense measures) towards management of flood risks proper through and also influencing the vulnerability of society" (Klijn, Samuels, & Van Os, 2008, p. 308). The following sections present a general picture of these socioeconomic implications of natural disasters.

The issue of disaster vulnerability and its effect on lower-income communities is very important for this research. First, it is important to define vulnerability as it relates to disaster events. Social vulnerability can be described as "the specific social inequalities in the context of a disaster" and is based on "comparing the status of a group of people

either to a desired state-i.e.- basic human rights- or to that of another group of people who are in a better position to deal with the negative impact of a hazard" (Kuhlicke, Scolobig, Tapsell, Steinführer, & De Marchi, 2011, p. 790). Additionally, it is not "a single variable that produces the vulnerability of a person; it is rather a combination of different variables but also, importantly, the respective societal content…there are many 'immaterial' aspects, such as local knowledge, culture, traditions, norm and mores" (Kuhlicke et al., 2011, p. 792). Conclusively, vulnerability to natural disaster is "seen not just as a product of physical location by also as a social product" (Few, 2003, p. 50). Because of their limited financial means, inaccessibility to facilities, political underrepresentation, and low quality dwellings, communities of low-socioeconomic status are more vulnerable and less resilient to extreme weather events. Additionally, once they are affected, it is more difficult for these areas to reestablish themselves.

Matters become worse for these communities when they have little choice but to reside in hazardous areas, which will allow weather events to further affect them in the future. He explains that the "poor tend to occupy the more flood-prone environments" (Few, 2003, p. 49) and "poverty can drive people towards settling and working in precarious locations such as unstable riverbanks in farming areas. In urban areas exposure to flood hazard tend to be concentrated in marginal, low-lying sites along rivers, on floodplains and coastal marshes- sites historically avoided by the better-off but often settled by the poorest communities because of their availability and/or proximity to sources of economic livelihood" (Few, 2003, p. 49). Additionally, "squatters tend to find there is less danger of eviction by city authorities if they locate to areas deemed undesirable for

legal private or public development" (Few, 2003, p. 50). Moga (2010) also examines the relationship between low-income residents and their low-lying flood prone properties. Specifically, in the United States "urban low land residential districts became ubiquitous: they served as containment areas for many desperately poor people seeking opportunity in the city, finding housing nowhere available but in the topographical low zones" (Moga, 2010, p. 13).

Morrow (1999) also discusses the financial, physical, social, and mental effects that floods disproportionately have on low-income communities. Morrow stresses the need for planners and policymakers use this knowledge in order to implement better protection strategies and equal emergency response among communities. Additionally, low-income communities are not only affected the most by extreme weather events, but they continuously feel the burdens long after the event. If they are affected because they live in a floodplain, or other hazardous areas, they are also likely to become victim to another disaster. Morrow explains "typically, poor households recover more slowly and many never fully regain pre-impact levels, increasing their vulnerability to future hazards" (Morrow, 1999, p. 3). She additionally supports this paper's claim that poor communities settle on cheaper areas where the wealthy will not develop to avoid storm damage. She explains "the dwellings of the poor are often located in vulnerable locations, such as floodplains. While the affluent build large homes in coastal floodplains for the ambiance, the poor are likely to have little alternative if their livelihoods are tied to tourism, fishing, and other coastal enterprises" (Morrow, 1999, p. 3).

These socioeconomic concerns can be seen in Prague. The evolution of Prague since the fall of communism is seen through the commercial and business evolution of Prague 1 and 2, gentrification, abandonment, and the urban sprawl in other areas of the city. As aforementioned, Prague 1, the historical center, has attracted business and commercial development. It contains "over half of the total city office stock, it is a place where nearly half of Prague's retail turnover is realized and where approximately one third of all jobs is concentrated. Residential function is steadily declining since the beginning of the 20th century, while government buildings, banks, and office buildings are increasing their share of land use in the area" (Sýkora, 1999, p. 82). This statement reinforces the argument that Prague 1 and 2 acquires significant revenue while also acting as the iconic historical center. Between jobs and tourism, these areas are an asset to the city and country; therefore, they need to be protected. The article then creates a contrast between Prague 1 and 2 and the inner city. The inner city areas of Prague "have old and low quality dwellings in dilapidated houses" (Sýkora, 1999, p. 80). According to the article's map of the inner city, it extends to Prague 8, one of the most flood prone areas of the city which will be discussed later in the paper. There are different types of areas in the inner city, however. While there are many low-quality dwellings, it has also become gentrified in Vinohrady, which is located on a hill away from the river. Ultimately, two fifths of Prague's residents live in the inner city, and because it does extend to a floodplain and does house such a large part of Prague's population, it is important to ensure that those areas are receiving adequate, if not equal, protection and relief from flooding.

The floods' threats to Prague's unique historical sites are only a portion of the impacts. Many residents, who live adjacent to the Vltava River and within the 100-year

floodplains, are displaced and burdened with significant flood damage. As a visitor during flood events, one can see that the protection measures in Prague 1 and 2, the historical, business, and wealthy areas are significant. However, it is less clear if the other affected areas are equally protected. As the largest city and economic resource in the Czech Republic, lower income people flock to Prague in hopes of finding job opportunities. This also means that expensive rent will drive people to live in undesirable, cheap, and more hazardous areas of the city. Because tourism is a significant part of Prague and the Czech Republic's GDP, it likely also employs many people who may not otherwise have jobs. This is another reason why lower income people must reside in Prague instead of a less expensive area of the Czech Republic.

General Flood Protection and Management Strategies

Disaster reduction policies are essential for the protection of the citizens, the economy, and environment in every country around the globe. Because disaster events are likely to reoccur, this realization has created a paradigm that has "shifted toward addressing the root causes of vulnerability to disasters, either through structural or non structural adaptations"(Solecki, Leichenko, & O'Brien, 2011, p. 136). The paradigm also "focuses on risk assessment, vulnerability to multiple stressors, livelihoods and well-being, institutional capacity building, risk mitigation investments, catastrophe risk financing, as well as emergency preparedness" (Solecki et al., 2011, p. 136). Ultimately, many factors must be considered for disaster related policy enforcement, and because less resilient areas often physically and financially burdened the most, it is important for these policies to benefit all at-risk communities equally.

Continued pressure and oversight on the governments is essential because these policy objectives are not always reached. The topic "safe development paradox" is explored discussed in Burby's (2006) article and explores the implications of poor development policy in floodplains and the government's failure to protect people in these areas after the damage is already done. In the article, Burby argues that the "extensive damage in New Orleans and the trend in increasing numbers and severity of disasters are wholly predictable outcomes of well-intentioned, but short-sited public policy decisions"(Burby, 2006, p. 172) and therefore, they try and "make hazardous areas safe for development, government policies instead have made them targets for catastrophes" (Burby, 2006, p. 172). After these types of disasters, "citizens bear the brunt of losses in disasters" and "local officials often fail to take actions necessary to protect them"(Burby, 2006, p. 172). As seen in the socioeconomic implications of flooding section, citizens, especially low-income communities, are most affected by the disaster. This outcome is ultimately because policy decisions allow people to live in vulnerable and low resilient areas of cities. Because public policy decisions have helped make communities more vulnerable, they can also be used to achieve resiliency.

More specific to Europe, mapping and hydrological models that analyze flood risks throughout the Europe are also a crucial part of disaster recovery and prevention. They evaluate the damage costs of the expensive flood events. The European Union issued a directive to its Member States to prevent flood related problems in their countries. The directive requires "Member States to carry our preliminary assessment to identify the

river basins and associated coastal areas at risk of flooding. Such zone then will be subject to flood risk maps and flood risk management plans" (Genovese, 2006, p. 13). The EU has other measures and programs to prevent flood related disasters and emergency funds for disaster recovery. These policies include the EU Structural Fund Policy, INTERREF Programmes, and the European Union Solidarity Fund (Genovese, 2006, pp. 13-14). This report explains that while the EU provides incentives and programs to help Member State's deal with flooding, they do not have specific flood management strategies or development policies for each Member State. Therefore, the Czech Republic must establish these policies.

Flood Protection and Management in the Czech Republic

Successful flood management and protection policies are essential in Prague especially with increasing intensity and frequency of flood events within the past two decades. Protection policies can range from prevention of flooding, like water barriers that are commonly seen along the Vltava in Prague's center, to development policies that prevent development along flood prone areas.

Before discussing structural and non-structural programs in Prague, it is important to know where the resources are coming from. Currently, the Czech Republic acquires disaster relief funds from multiple places. First, the European Union has established a Solidarity Fund after the widespread flood disasters in 2002 and 2003. Because of establishment of this fund, "Member states, and countries applying for accession, can request aid in the event of a major natural or technological disaster" and "provides financial aid for emergency measures in the event of a natural disaster causing direct damages above three

billion Euros or .6% of the GNI" (Aakre et al., 2010, p. 731). Along with the Solidarity Fund, flood protection infrastructure and flood defense measures came from state budget subsidies, which come from European Investment Bank (Puncochar, 2012, p. 1). Another important program comes from the Ministry of the Environment and uses European Funds via the "Operational Programme Environment" in the measure of the "watershed management infrastructure improvement and reduction of flood risks" (Puncochar, 2012, p. 3). While there are other relief programs, these are among the most prominent in the related literature.

Structural/ Governmental Flood Protection

After the devastating floods in the Czech Republic, the Ministry of Agriculture created a program that composed of five elements that are "aimed above all, at the creation of water storage capacity and the protection of dwellings" (Jirasek, 2006, p. 264)The elements include:

- Construction of polders, reservoirs, and levees
- Increasing watercourses capacity in developed areas
- Delineation of flood-prone areas
- Run-off condition studies
- Delineation of areas threatened by extraordinary floods

The Protection from Floods section in the Czech Republic's Water Act outlines fourteen preventative flood measures and four measures that are taken during flood events. They are as follows:

Flood Prevention Measures	Measures taken during Floods
1. Determination of Flood plain areas 2. Specification of limits for flood protection activity degrees 3. Flood protection plans 4. Flood protection inspection 5. Organization of flood forecasting and reporting services 6. Organizational and technical preparation 7. Creation of flood reserve stock 8. Clearing of flood plain areas 9. Training of persons participating in flood protection activities 10. Activities of the flood forecasting service 11. Activities of the flood reporting service 12. Warning in case of danger of floods 13. Establishment and activities of the watching service 14. Flood recording documentation	1. Regulating of flow regime 2. Flood protection activities (like placing sandbags, constructing flood barrier walls) 3. Flood rescue activities 4. Activities aimed at ensuring substitute functions and services in territories affected by floods

The flood prevention strategies that are repeatedly emphasized in the document are establishing floodplains, have routine flood inspections, and municipalities are required to submit flood protection plans to the River Basin Administration for review. When the

floodplains are established, the Act restricts any development of the floodplains unless it is a structure related to water management. The Act specifies that "locating, permitting and building structures inside the active zone of the flood plain area is prohibited except for water management structures aimed at regulating the watercourse, flood flow routing, performing flood protection measures or measures which are otherwise related to the watercourse or improve the flow regime, structures for water retention, waste water and rain water disposal and also necessary transport and technical infrastructure" ("The Water Act," 2001)

Additionally, the Czech Republic has developed sophisticated flood models to determine the damage and therefore successful policies for flood protection. To determine these effective flood protection strategies, the Czech Technical Institute in Prague "developed a system of three methods of damage evaluation with different levels of accuracy. All three methods are based on the same approach, using object-oriented land use information, an estimation of values of assets and risk per meter, main based on data from official statistics, and a kind of relative damage function" (Meyer & Messner, 2005, p. 17). Furthermore, when prioritizing localities to implement these programs, "the amount of risk was evaluated in each given locality and the selection process was based on the assessment of the dwelling priority (number of affected inhabitants, the extent of probable damage, historical relations), on the existing capacity of the riverbed and on the locality's proneness to floods"(Jirasek, 2006, p. 264). This program for assessing priorities seems affective.

Non Structural/ Financing Disaster Preparedness and Responses

The Czech Republic does consider social vulnerability and prioritizes the human safety and protection. Therefore, non-structural and financing plays a large role in the Czech's flood mangement programs and systems. Jelínek (2007) explains that the Czech Republic indicated how "various categories of typically vulnerable objects are prioritized for flood risk management in their countries" (Jelínek, Wood, & Hervás, 2007). "Humans as Individuals", "Humans as Social Targets" and "Private Property" are ranked "Very High" and "High" on the Level of importance of the elements at risk exposed to flood hazards in the Czech Republic. These priorities explain that vulnerable human populations are the most important factors in flood events, and therefore, the government should be establishing higher flood policy and development standards.

Before making recovery allocation decisions to address this vulnerability, decision-makers have many factors to consider. An important way to make these decisions is considering the normative welfare theory, a "branch of economics which accesses society's welfare based on the objectives of allocated efficiency, distribution among agents and stabilization among the economy" and has been used to decided how "governments should intervene in order to facilitate adaptation"(Aakre et al., 2010, p. 723). The three main pillars of the welfare theory are allocation, distribution, and stabilization. Specifically, the functions of the government in these three factors are "(1) generating an efficient allocation of goods and services, (ii) ensuring an adequate distribution of income. as well as (iii) stabilizing the economy" (Aakre et al., 2010, p. 723). These pillars ultimately outline the role of public decision making and the importance of addressing each of these factors. These factors will be used to analyze the

public sector's flood relief strategies in Prague. As the Czech Republic addresses flood this vulnerability, it is important that they use every possible nonstructural tool to repair the affected areas and to build their future resilience. Equal distribution of these resources is among one of the most important responsibilities of the governing bodies. Prague and flood resource allocation is no exception.

Along with public flood management efforts, flood insurance also plays a large role in disaster relief. Although insurance may not directly be a government responsibility, public access to insurance benefits people and the government. The government aims to reduce the amount of financial burden on the state, so implementing adequate insurances policies is necessary. Additionally, the financial burden may not be so heavy on lower-income residents. Essentially, "transferring risk management responsibilities to the property owner by introducing more private insurance in a region is one way of coping with losses" (Hansson, Danielson, & Ekenberg, 2008, p. 468). While insurance is a positive factor in flood recovery, it can be esoteric and can prevent some residents from gaining access to it. For instance, increasing an insurance premium on a flood risk property can be expensive, thus prohibiting people from moving into the area. However, many lower-income, less-educated residents need to live closer to the center of Prague because of higher employment opportunities. Therefore, it can come down having a job with no insurance in a flood plain, or living outside of the floodplain with fewer job opportunities.

Czech insurance, while advanced, still has issues that need to be addressed in order to promote social equity throughout the city. Currently, "the local insurance market offers an

all-risk inclusive property insurance policy, which besides traditional FLEXA perils also provides coverage against almost all known types of disasters" (Gurenko & Dumitru, 2009, p. 13). While there are 1,875,523 individual policies in the Czech Republic, the high number "conceals the problem with obtaining coverage for people living in flood prone areas as most insurers do not provide coverage" (Gurenko & Dumitru, 2009, p. 13). This issue has not yet become a political problem, and therefore there is "no pressure for the establishment of a national flood insurance pool" (Gurenko & Dumitru, 2009, p. 13). The article does mention, however, that gradually the flood barriers along the river will prevent damage to homes and development will gradually be prohibited along the river. It does not give a time frame for these goals and does not address whether or not the flood barriers are equally distributed along all riverfront areas. It is also important to note, however, that insurance companies are "reluctant in publishing data of insurance payments, apparently because it is business information" (Genovese, 2006) and are of "little help in developing flood damage assessment methods" (Genovese, 2006). This will be discussed in the concluding recommendations of the paper.

Despite the Czech Republic's efforts to improve flooding management, there are major issues in this system that interferes with more success flood management. Due to data limitations, experts have not necessarily established the relationship between flood damage and relief funding per municipality. While this source addresses relief allocation in South Bohemia, not Prague specifically, it explains that fund allocation in the Czech Republic as a whole is nebulous. It explains that once disaster strikes, the Czech government only calculates damages. The calculation of damages is based on the Ministry of Finance's

methodology, which is not described in detail in the literature. Therefore, the article suggests that " the amount of damage determined immediately after the emergency event does not necessarily correspond to the actual amount" and ultimately "we cannot yet talk about evaluation of efficiency in financing the recovery of the areas affected by the emergency event and prevention" (Bakoš, Binek, Rektořík, & Šelešovský, 2011, p. 8) Therefore, it can be understood that the government needs to make this relationship more transparent in order to make more equitable and efficient decisions.

Conclusion

Globally, natural disasters carry many socioeconomic implications and illustrate the vulnerability of lower income communities to these events. Vulnerability is often human Induced due to the affordability of hazardous land and low quality dwelling units. Additionally, these communities often go underrepresented in disaster recovery. This is all too common injustice could also be prevalent in Prague. While Prague has made strides to protect historical and wealthier neighborhoods from flooding, it is less clear whether other areas along the river receive similar attention. The next section takes an analytical look at the potential socioeconomic issues of flooding during the 2002 and 3013 events.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

The Research Design for this paper is composed of three elements: socioeconomic data for each municipality of Prague, flood damage costs for municipalities of Prague, and flood level maps of the Vltava River. Flood damage data is not readily available, and therefore, cannot be the main driver of the analysis for my paper. The first step of this analysis is to understand the socioeconomic situation in Prague. After searching through the data available through the Czech Administrative office, Low Quality Dwelling Units, Rate of Residents low education levels, and the percent of non-Czechs/minorities in each district are the main socioeconomic indicators of my research. Note that the education section is the amount of residents with no formal education level plus the amount of residents with low education levels. The non-Czechs variable includes Slovakian, Ukrainian, Roma and Vietnamese. Income level per administrative district would be a strong variable for the analysis, but was not available through the Czech Statistical Office. The following section discusses the analysis of these socioeconomic indicators maps.

The second element of the research design will compare the socioeconomic indicators to the amount of flood damage in each of the nine administrative districts that run along the Vltava river and are, therefore, more vulnerable to flood damage. This information will help determine if there appears to be a correlation between the aforementioned socioeconomic factors and the amount of flood damage the district receives. The Czech government follows a specific and complex formula to determine flood damage costs.

This flood damage theorem depends on "three pieces of information: the damage categories affected and included, the data on damaged objects as well as the damage function and factors to be applied. For buildings, which form the most significant damage category, the formula for the estimation of damages to an individual building floor under water reads:

DAMAGE= H*C*%p*A (in CZK)

H [m]= Height of an individual Building

C [Kč/m^3]= Price of a cublic meter of a building based on JKSO data

A [m^2]= Ground floor area of the building (GIS based)

%p [-}= Percentage of damage to building according to damage function (Meyer & Messner, 2005)

As aforementioned, the flood damage information is not readily available. After contacting people from the government and nongovernment sector, I have repeatedly been informed that a record of total flood damage costs per municipality does not exist. Prague municipalities do not report total flood damage costs to an overall database. However, the Chapter IX- Protection Against Floods, of the Water Act, states that municipalities are required to "determine the extent and level of the flood damages, assess effectiveness of the implemented measures and submit a report on the flood to the flood protection authority of the municipality with the extended jurisdiction" ("The Water Act," 2001, p. 41) Therefore, it seems that an official database should exist. Furthermore, this information will conclude whether or not socioeconomic implications play a role in

the amount of flood protection the area receives. If there is a clear correlation, policies need to be mandated to prevent inequity during major flood events. Unfortunately, this section will require further research in the future because of the lack of available data.

Socioeconomic GIS Analysis

The City of Prague is composed of twenty-two Administrative districts, nine of which run along the Vltava River. As part of the Methodology, I have chosen three variables from the Czech Statistical database that describe the socioeconomic status of each Administrative districts in Prague. The data has been exported from the Czech Statistical Office (CSO). Using the join function in ArcGIS, these socioeconomic indicators were merged to Prague's administrative boundaries shapefile. These rates were divided into quantiles. The quantiles make the information in the districts easily distinguishable from each other. The lowest percentages are yellow while the higher percentages are represented by dark orange and red. Ultimately, these maps serve to give a physical representation of these statistical variables within the city. The socioeconomic variables exported from the CSO are the following:

- Ethnicity
- Education Level
- Quality of Dwelling

Figure 2

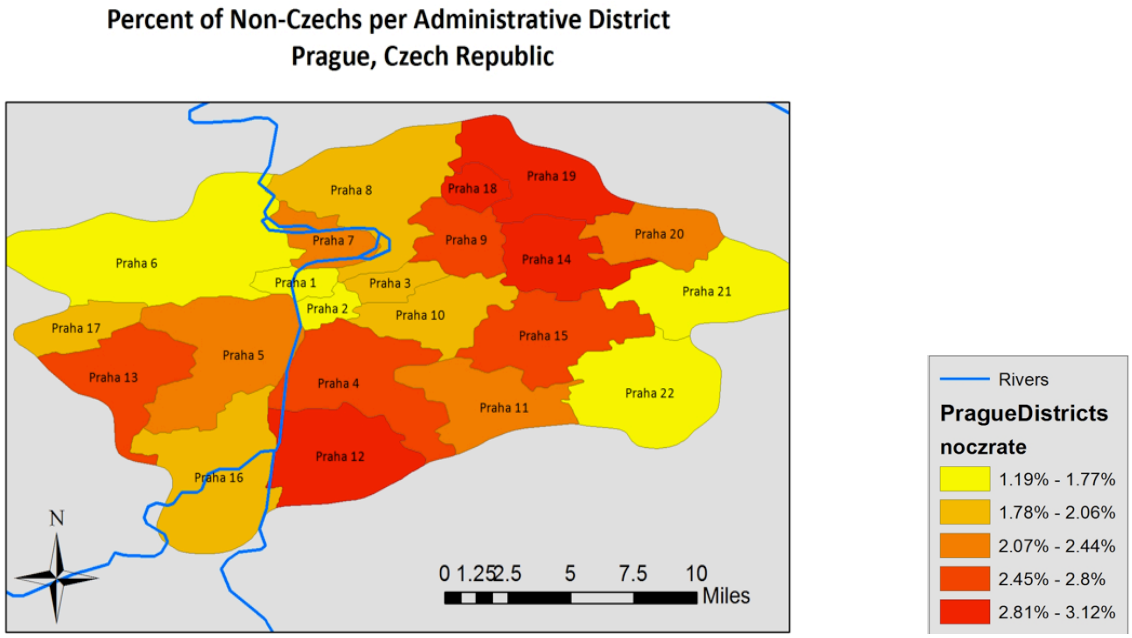


Figure 3

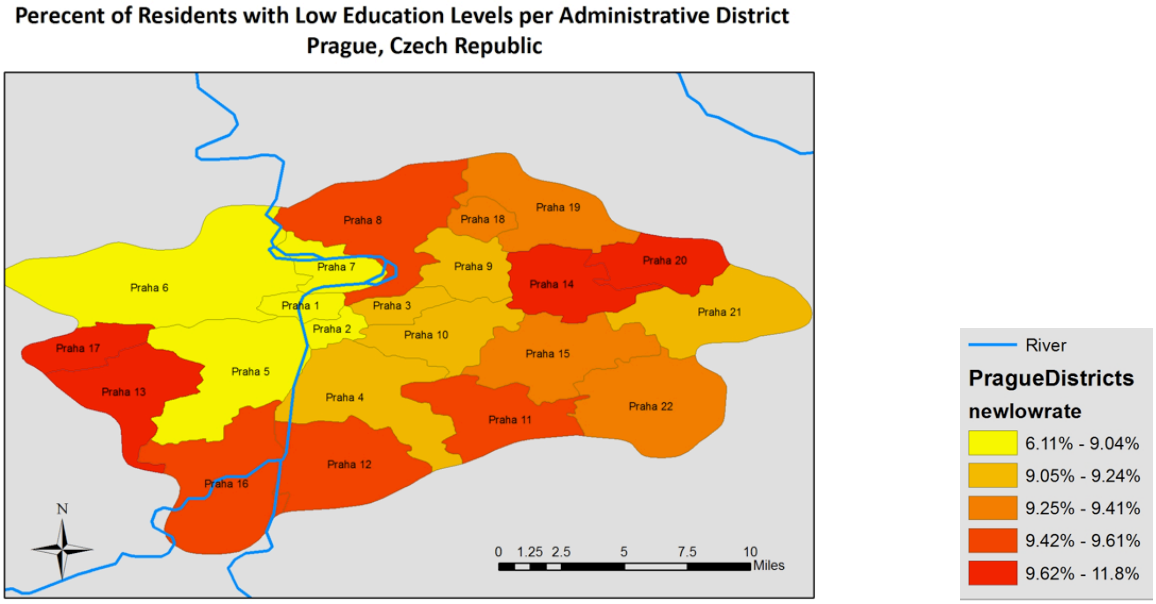
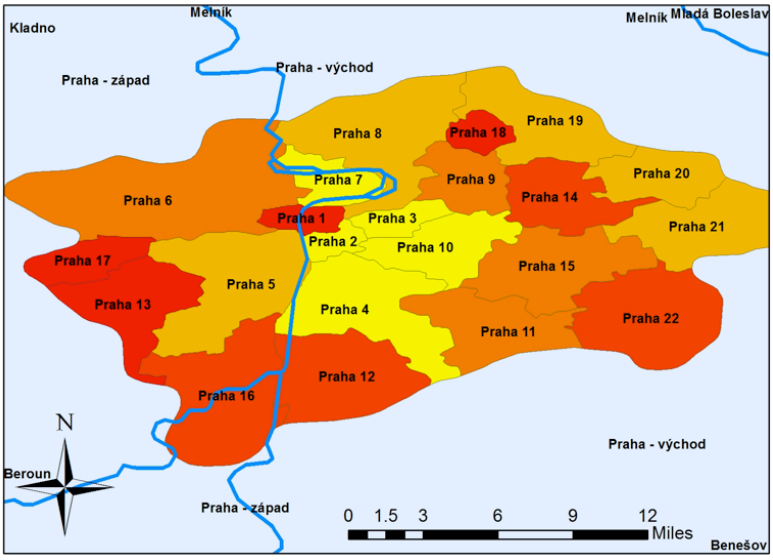
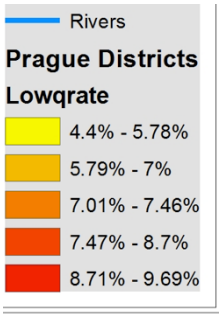


Figure 4

Percent of Low Quality Dwelling Units per Administrative District
Prague, Czech Republic





Socioeconomic Findings

The three maps of Prague (above) provide a socioeconomic framework of Prague. There are three different themes: Number of Non-Czechs per Administration District, Percent of Low Quality Dwelling Units per Administrative District, Percent of People with No Formal Education per Administrative District. Each of these variables can be associated with lower socioeconomic status in districts. The non-Czechs map is composed of Ukranians, Roma, Vietnamese, and Slovakians. The prominence of these minorities in a district could suggest lower-income status. The percent of low quality dwelling units per administrative district are dwelling units that are considered to be below average quality, but still might have proper piping, water, and other utilities. Sub categories within the Dwelling category database include standard quality dwelling units, Privately owned and publicly owned dwelling units. Percent of population with No Formal Education is composed of people who do not have a grade school degree and people who only have a grade school degree. Other variables from the educational database include amount of people with Bachelor degrees, High School degrees, and Master's degrees.

Because the focus of the research paper is investigating the areas prone to flood events, I will be specifically exploring districts along the Vltava River, represented by the blue line. These districts include Prague 8, Prague 7, Prague 1, Prague 3, Prague 5, Prague 4, Prague 16 and Prague 12. The yellow is the lowest possible percentage and red represents the highest percentage.

Percent of non-Czechs per Administrative District- As the first map (Number of Non Czechs per district) indicates, Prague 5, Prague 7, Prague 4, and Prague 12 have the higher rates of Non-Czechs in the city. Prague 4, and Prague 5 shows between 2.27% and 2.55%of Non-Czechs. Prague 7 has between 1.9% and 2.3%. Non-Czech and Prague 12 has the highest rate, between 2.556% and 3.12% of Non-Czechs. Ultimately, Prague 12 has the highest rate of minorities in the City of Prague.

Percent of Residents with Low Education Levels per Administrative District- The second map, Percent of Residents with Low Education Levels per Administrative District is the combination of people with no formal education and low education attainment. The highest rates of no formal education are in Prague 8 Prague 12, and Prague 16 with rates between 9.41% and 9.61%. Prague 4 has the second highest rate between 9.23% and 9.41%.

Percent of Low Quality Dwelling Units per Administrative District- The third map, Percent of Low Quality Dwelling Units per Administrative District shows Prague 1. The amount of low quality dwellings could be representative of neighborhoods with a lower socioeconomic status because of the residents' inability to pay renovations and improvements. The map suggests that Prague 1 has the highest rate of Low quality dwelling units, which falls between 7.93% and 9.69%. This is interesting because Prague 1 is known as the City's center, composed of businesses and tourism and is considered to

be the nicest area of the city. Old traditional structures could be the result of these higher numbers, but would require additional research. Prague 16 and Prague 12 have the second highest rate between 7.24% and 7.9%. Prague 5 has the third highest rate of Low Quality Dwelling Units between 5.79 % and 7.23%. Other high rates of these inadequate dwellings are towards the outskirts of the city.

GIS Map Conclusions

The socioeconomic factors in each district prove to not be completely consistent. However, Prague 12 and Prague 16 are darker colors in all three maps and can conclude that these two districts have high rates of non-Czechs, low quality dwelling units, and lower educated residents when compared to the rest of the city. This consistency suggests that these districts are considered to be lower in socioeconomic status, and therefore, could be more vulnerable to flooding. With this knowledge, special attention needs to be paid to these areas during flood damage and flood levels analysis in the following sections.

Tentative Flood Damage Costs Per Administrative District

Although was unable to collect substantial flood damage information, I wanted to include the damages I was able to gather. The information in Table 1 indicates that Prague 8, Prague 7, and Prague 1 received the most damages in 2002. Prague 7, Prague 5, and Prague 16 received the most damages in 2013. This tells us that Prague 1 was and 8 were taken care of for the 2013 floods, while Prague 7 might again not have been protected enough. Prague 5 and 16 might have also not been as heavily considered when preparing for the floods in 2013.

Table 1: Flood Damage Costs per District

Flood Damage Costs per district	**2002**		**2013**	
	CZK	$	CZK	$
Prague 8	8000000000	400000000		
Prague 7	308589000	15429450	341415000	17070750
Prague 1	104714500	5235725	7915000	395750
Prague 2				
Prague 4				
Prague 5	60000000	3000000	48290000	2414500
Prague 12				
Prague 16	42783000	2139150	32012000	15600

Measure of Flooding in Meters Per District

Through the government's published flood maps, I was able to measure the flooded areas in Meters for both 2002 and 2013. With this information, I was able to determine what areas received the most flooding and the change of flood levels between 2002 and 2013. The change in flooding can suggest whether or not certain areas were more protected for the 2013 floods and what areas might not have received ample flood protection.

Table 2, below, demonstrates flooding in meters for 2002 and 2013. It also illustrates the change in meters and the percent change in flooding for the two years. The chart is based off the table and provides a visual representation of these number changes.

Flooding Analysis:

Prague 8: Prague 8 is one of the two districts that received more flooding in 2013 than in 2008. Table 2 shows that it has a 8.1% change in flooding between the two years. Although this number might not be astronomical, it is encourages the question as to why this area, during a less substantial flood, received more flooding than it did during the worst flood event in decades. This question then leads us to look at the socioeconomic status of the district in the previous section. The maps reveal that Prague 8 lies within the mid socioeconomic range. It has a lower percentage of non-Czechs compared to other

districts, it has one of the highest rates of low education levels, and one of the lower rates of low quality dwelling units. This reveals that it is inconclusive whether or not the amount of flooding can be directly related to socioeconomic status. It is possible that the flooding could do with geographical factors (like the natural curve of the river), but would need to be investigated further.

Prague 7: The chart indicates that flooding in Prague 7 improved from 2002 to 2013, but it is the district with the second highest amount of flooding. So while it is positive that flooding has improved, specifically by 9.3%, it is still troubling to see the district have such drastic amount of flooding. The socioeconomic GIS analysis of the area suggests that, like Prague 8, it seems to lie in the middle of the socioeconomic range. It as a mid-rate of non-Czechs per administrative district, the lowest amount of residents with low education levels, and the lowest amount of low quality dwelling units. This suggests that there does not seem to be an apparent correlation between socioeconomic factors and the amount of flooding the district receives. Because it is directly adjacent to Prague 8, it could share the same geographical problems that make it naturally more prone to flooding. This would also need to be investigated further.

Prague 1: Prague 1 seems to have one of the most drastic improvements from 2002 to 2013. Flooding decreased by 55%. As mentioned previously, Prague 1 is home to the most of the tourist attractions and businesses in Prague which suggests it has a relatively high socioeconomic status. It has the lowest amount of non-Czechs per administrative district, the lowest rate of residents with low education levels, but interestingly has the

highest rate of low-quality dwelling units. This should also be investigated further. However, with this socioeconomic status and economically important area of the city, it is likely that these factors encouraged the government to take extra precautions to protect this area from the 2013 flood.

Prague 2: Like Prague 8, district 2 received more flooding in 2013 than 2002 with a 5.4% increase. This is interesting because Prague 2 is similar to Prague 1 in terms of socioeconomic status. The GIS analyses indicate that it has the lowest rate of non-Czechs, the lowest percent of residents with low education levels, and the lowest rate of low quality dwelling units per district. Therefore with a relatively high socioeconomic status, there does not seem to be a correlation between flooding and flooding in the district.

Prague 4: According to Figure 5 there does not seem to be anything alarming about the flood numbers for Prague 4. The total flood rates are relatively low and flooding went down between 2002 and 2013. This is interesting because it is not a district of the highest socioeconomic status. It has one of the highest rates of non-Czechs, a middle rate of residents with low education levels, but one of the lowest rates of poor quality dwelling units. Therefore, it does not appear that socioeconomic injustice was a factor in these flood disasters.

Prague 5: Prague 5's scenario seems to appear fairly similar to Prague 4, in terms of the amount of flooding. The total amount of flooding is relatively low and it decreased

between 2002 and 2013. It also has a mid socioeconomic status. It has a mid rate of non-Czechs, the lowest rate of residents with low education levels, and a mid rate of low quality dwelling units. Therefore, socioeconomic injustice is not apparent in this district, either.

Prague 12: According to Figure 5, Prague 12 received a low percent of total flooding and even decreased slightly, 8.7% from 2002 to 2013. The GIS analysis also indicates that the area is of low socioeconomic status. It has a high rate of non-Czechs per administrative district, a high rate of residents with low education levels, and high rate of low quality dwelling units per administrative district.

Prague 16: Prague 16 raises the most concern. It has the highest amount of total flooding of all the districts, but also one of the significant changes. Flooding reduced by 47% between 2002 and 2013. While it is promising that these numbers decreased so significantly, the 2013 flood measurements are the second highest. Thus, not enough is being done to protect this area from flooding. The GIS analysis concludes that this area is of low socioeconomic status. It has a middle rate of non-Czechs per administrative district, a high rate of residents with low education levels, and a high rate of low quality dwelling units. This analysis suggests that socioeconomic injustice could be apparent in this area.

Conclusion: While these two factors (socioeconomic status and amount of flooding) do not show high correlations to one another, there are a few concerns. It is clear that

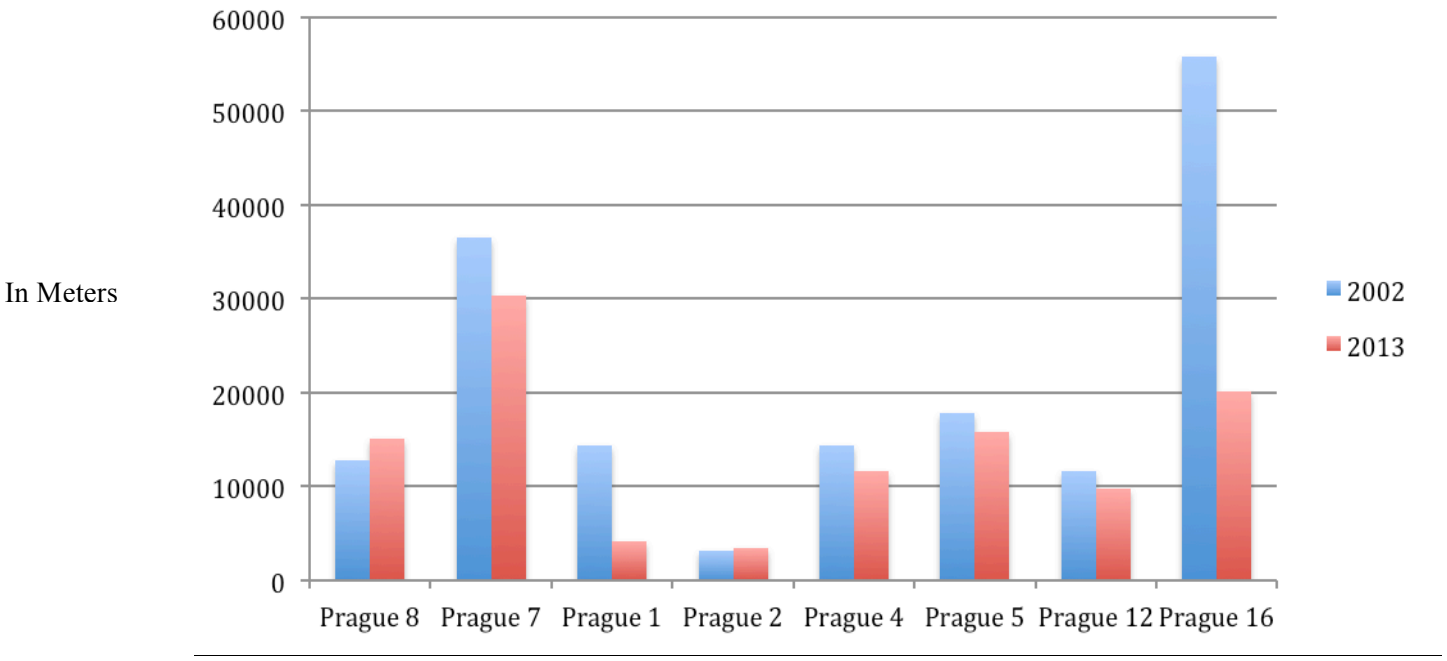
districts with the highest socioeconomic status are flooded the least, or have improved the most while the district with one of the lowest socioeconomic status had very high levels of flooding. Therefore, more detailed analysis needs to be done to closer investigate Prague 16 and more flood protection strategies need to be implemented in this area. n

These numbers are telling in the Czech government's potential flood protection strategies. The area that received the most flooding, Prague 16, received much less flooding in 2013. This suggests that this area may have been heavily protected. Prague 1 also received less flooding. As suspected in my original hypothesis, this area, the city center (for business and tourism) would have been one of the most protected areas for the 2013 floods. Prague 7, with the highest numbers, only changed slightly between the two years (change of 9.3%). This suggests that more precautionary protection measures should be put into place in order to prevent these high damages for the next major flood.

Table 2: Flooding in Meters per District

Flooding Per District	2002	2013	Change	Total	Percent Change
Prague 8	12814.7	15079.6	2264.9	27894.3	8.1%
Prague 7	36540.6	30292	-6248.6	66832.6	-9.3%
Prague 1	14424.9	4102.7	-10322.2	18527.6	-55.7%
Prague 2	3087.4	3441	353.6	6528.4	5.4%
Prague 4	14331.3	11668.1	-2663.2	25999.4	-10.2%
Prague 5	17801.8	15825.9	-1975.9	33627.7	-5.9%
Prague 12	11,587	9739.2	-1847.8	21326.2	-8.7%
Prague 16	55828.4	20,147	-35681.4	75975.4	-47.0%

Figure 5: Flooding in Meters per District



CHAPTER 4

RESEARCH CONCLUSIONS

While literature shows that the Czech Republic has taken tremendous structural and non-structural measures to protect the country and its citizens from flooding, it does not properly record information that can determine whether or not certain areas are more flooded than others. I have attempted to compile such data, but available sources have important gaps and, therefore, could not properly use the quantitative data to create a statistical analysis. A basic analysis was conducted that measured the amount of flooding in each focus district for 2002 and 2013. This analysis concluded the following: while these two factors (socioeconomic status and amount of flooding) do not show high correlations to one another, there are a few concerns. It is clear that districts with the highest socioeconomic status are flooded the least, or have improved the most while the district with one of the lowest socioeconomic status had very high levels of flooding. Ultimately, a more detailed analysis needs to be done to closer investigate Prague 16 and more flood protection strategies need to be implemented in this area.

Additionally, I recommend that the Czech Republic efficiently collects all flood damage costs in a common database and use these numbers to determine what areas are repeatedly flooded. Therefore, possible socioeconomic implications of flooding can be properly addressed.

CHAPTER 5

FURTHER RESEARCH AND RECOMMENDATIONS

Recommendations

In order to ensure that all residents are equally protected from major flood events, the government needs to introduce productive flood protection and recovery policies. The United Kingdom's guide on "Development and Flood Risk" explains that policies in redevelopment plans should outline the consideration which will be given to flood issues, recognizing the uncertainties that are inherent in the prediction of flooding and that flood risk is expected to increase as a result of climate change. Planning authorities should apply the precautionary principle to the issue of flood risk, using a risk-based search sequence to avoid such risk where possible and managing it elsewhere" (Pinnell, 2007, p. 213). This is important to keep in mind when thinking about flood management recommendations.

My research and conversations with Czech contacts suggest that strategies to determine damage costs may not be efficient or available. Determining the most damaged areas and the highest number of affected residents would be a strong policy for flood prevention and recovery, but detailed recording is necessary. Additionally, there are different types of properties that are damaged by the floods. For instance, there is public property and private property. The Czech Government and the European Union pay for damaged public property. Individual insurance companies pay for private property. However, different possessions and properties are often insured through different companies. For instance, a car can be insured through one company and an apartment

can be insured through another company. The different property owners and forms of insurance complicate the recording process. Every entity, whether public or private, should have to report each individual damage to a single database. These damages need to be reported down to the neighborhood and municipal level in order to determine what areas receive more flood damage than others. Additionally, in order to promote social welfare, the Czech government needs to put more pressure on insurance companies to make insurance options more affordable for lower-income residents, while also encouraging them to use their data in order to build flood resilience in the city.

As Klijn suggests, people need to control the flood risk and not the flood itself. Therefore, the government, being the ultimate decision maker in the country, must influence the movement away from settlement on high risk properties and the aesthetic appeal on living, or working along the river front. As aforementioned, the Water Act does discourage floodplain development, but as a regulation and not necessarily a policy. Incentives could be fundamental policy tools for reducing flood risk. Such policies could encourage financial incentives for developers to build in safe areas. Other incentives could encourage landlords and building owners to improve the quality of the dwelling units in other, less hazardous areas of the city. If dwelling units are improved in other areas of the city, Prague residents might be more encouraged to live there. As discussed throughout the paper, the center of Prague is located along the Vltava. The center and downtown, therefore, is where many businesses and jobs are located. Therefore, the units that are proposed to be improved should be located within close proximity to metro and tram stops so residents will have easy access to jobs within the center. Ultimately, best

flood protection stems from appropriate spatial planning. By concentrating on spatial planning, such as prohibiting development on floodplains, we eliminate the risk.

Further Research

As aforementioned, detailed historic records and flood damage information is extremely important when determining a model for future flood protection and prevention. Several sources from the Czech Republic have informed me that the City of Prague does not have a single database with the total flood damages per administrative district. With this information, the government could know the flood damage costs down to the parcel level and could, therefore, determine if specific areas are repeatedly burdened by tremendous flood damage. Similarly, England has a "hot spot" program that combines "all modeling studies and records of flood events were combined to produce one flood outline. This work carried out as part of the hotspot studies" (Pinnell, 2007, p. 215)These hotspots were then reported to local planning and governing agencies to redevelop and plan accordingly.

Because of the geographic barrier and difficulty attaining information about a county overseas, more needs to be done to solidify this research. In order to truly get a sense of the socioeconomic situation of each area, more qualitative research needs to be done. Such qualitative research involves surveying and household interviews. It is important to "understand how individuals belonging to certain communities and cultures frame the experience of their physical and social environment" (Kuhlicke et al., 2011, p. 795)Such qualitative information can also help to "identify dominant patterns within, but also between, case studies along the different phases of the event" (Kuhlicke et al., 2011, p. 795)Interviews and surveys data can go beyond the physical pattern that was illustrated

through GIS maps. This data will allow exploration and understanding into the personal and equally important personal and life style patterns in the community. The following table, borrowed from *Contextualizing social* vulnerability*: finds from case studies across Europe* illustrates important information we can learn from collecting qualitative information about social vulnerability related to flooding. This information will not only solidify quantitative data already gathered, but provides understanding about the extent of the impact that flooding had on the residents.

Anticipation	Prior awareness, prior preparedness, adoption of preparatory measures, Holding insurance, being warned and/or evacuated, Interpretation of warning
Resistance and Coping	Flooding of residential property, Information during flood, help received during flood, evacuation
Recovery and Reconstruction	Material damage, overall impact, monetary compensation, adoption of preparatory measures, post-awareness, post-preparedness

(Kuhlicke et al., 2011)

REFERENCES

Aakre, S., Banaszak, I., Mechler, R., Rübbelke, D., Wreford, A., & Kalirai, H. (2010). Financial adaptation to disaster risk in the European Union. *Mitigation and Adaptation Strategies for Global Change, 15*(7), 721-736. doi: 10.1007/s11027-010-9232-3

Bakoš, E., Binek, J., Rektořík, J., & Šelešovský, J. (2011). Supporting Mechanisms in Decision Making about Allocation of Resources in Crisis Management Process. *Economika a Management* 7.

Burby, R. J. (2006). Hurricane Katrina and the paradoxes of government disaster policy: Bringing about wise governmental decisions for hazardous areas. *Annals of the American Academy of Political and Social Science, 604*, 171-191. doi: 10.1177/00027162052s4676

. Czech Republic: Insurers to tighten conditions for properties near floodplains. (2013) Retrieved March 4, 2014, from http://www.businessinsurance.com/article/20130924/NEWS09/130929942

Few, R. (2003). Flooding, vulnerability and coping strategies: local responses to a global threat. *Progress in Development Studies, 3*(1), 43-58.

Fraser, C. (2013). Floods threaten Dresden as Prague river levels fall. Retrieved from http://www.bbc.com/news/world-europe-22752544

Genovese, E. (2006). A methodological approach to land use-based flood damage assessment in urban areas: Prague case study *Technical EUR Reports, EUR* (Vol. 22497).

Gurenko, E. N., & Dumitru, D. (2009). Review of Public and Private Disaster Risk Financing Mechanisms in Central Europe. *World Bank*.

Hansson, K., Danielson, M., & Ekenberg, L. (2008). A framework for evaluation of flood management strategies. *Journal of Environmental Management, 86*(3), 465-480. doi: http://dx.doi.org/10.1016/j.jenvman.2006.12.037

Jelínek, R., Wood, M., & Hervás, J. (2007). Risk Mapping of Flood Hazards in New Member States. *EU Joint Research Centre, IPSC, NEDIES, EUR, 22902*.

JIRASEK, V. (2006). HISTORICAL 2002 FLOOD IN CENTRAL EUROPE AND FLOOD DEFENCE: Situation in the Czech Republic, illustrated with the Elbe River Basin Experience *Flood Risk Management: Hazards, Vulnerability and Mitigation Measures* (pp. 261-265): Springer.

Klijn, F., Samuels, P., & Van Os, A. (2008). Towards flood risk management in the EU: State of affairs with examples from various European countries. *International Journal of River Basin Management, 6*(4), 307-321.

Kuhlicke, C., Scolobig, A., Tapsell, S., Steinführer, A., & De Marchi, B. (2011). Contextualizing social vulnerability: findings from case studies across Europe. *Natural Hazards, 58*(2), 789-810.

Meyer, V., & Messner, F. (2005). National flood damage evaluation methods: A review of applied methods in England, the Netherlands, the Czech Republik and Germany: UFZ-Diskussionspapiere.

Moga, S. T. (2010). *Bottoms, Hollows, and Flats: making and remaking the lower section of the American city.* Massachusetts Institute of Technology.

Morrow, B. H. (1999). Identifying and mapping community vulnerability. *Disasters, 23*(1), 1-18.

Pinnell, M. (2007). Sustainable Development and Flood Risk–Reducing Uncertainty (Bristol City Re-Development Case Study) *Flood Risk Management in Europe* (pp. 213-229): Springer.

. Prague History. (2010) Retrieved 10 February, 2014, from http://www.czech.cz/en/Discover-CZ/Facts-about-the-Czech-Republic/History/Prague-history

Puncochar, P. (2012). Flood Protection in the Czech Republic and International. Prague Ministry of Agriculture, Water Management Section.

SKLENÁŘ, P., ZEMAN, E., ŠPATKA, J., & TACHECÍ, P. (2006). FLOOD MODELLING CONCEPT AND REALITY-AUGUST 2002 FLOOD IN THE CZECH REPUBLIC *Transboundary Floods: Reducing Risks Through Flood Management* (pp. 155-170): Springer.

Solecki, W., Leichenko, R., & O'Brien, K. (2011). Climate change adaptation strategies and disaster risk reduction in cities: connections, contentions, and synergies.

Current Opinion in Environmental Sustainability, 3(3), 135-141. doi: http://dx.doi.org/10.1016/j.cosust.2011.03.001

Stocker, T. F., Qin, D., Plattner, G.-K., Tignor, M. M. B., Allen, S. K., Boschung, J., . . . Midgley, P. M. (2013). Climate Change 2013: The Physical Science Basis. Contribution of of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (pp. 1535). Cambridge: Cambridge University Press.

Sýkora, L. (1999). Changes in the internal spatial structure of post-communist Prague*. *GeoJournal, 49*(1), 79-89.

Vltava River. 2014, from http://www.pragueexperience.com/places.asp?PlaceID=1218

."*The Water Act*". (2001). Prague, Czech Republic.